Active Project (2014 - 2016)

F-band, High-Efficiency GaN Power Amplifier for the Scanning Microwave Limb Sounder and SOFIA, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

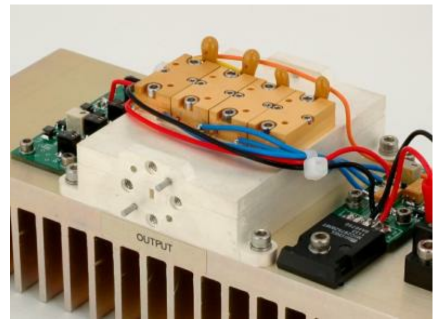
ABSTRACT

QuinStar Technology proposes to develop a high-efficiency, 4-W SSPA operating at F-band frequencies (106-114 GHz). This will be achieved by employing two major innovations. Firstly, we are employing state-of-the-art wide bandgap GaN (Gallium Nitride) devices. At millimeter-wave frequencies, these GaN devices have demonstrated power densities of 5 to 8 times higher than GaAs or InP devices. Further, we are proposing to operate these devices in a quasi-switching mode, which has demonstrated, in Phase I simulations, drain efficiencies approaching 70%. The resulting MMIC, operating over the 106 to 114 GHz band, will produce an output power of one watt and an efficiency of greater than 33%. Secondly, we are proposing to utilize a new low loss, H-tee combining approach to combine 4 of these high-efficiency chips to achieve 4 watts. The net result is a unique combination of high performance devices and innovative power combining. We anticipate that this work will result in an order of magnitude increase in the state-of-the-art of SSPA output power and efficiency at F-band. We anticipate that this work will be very important for NASA's Earth Science missions and for DoD W-band radar and communications applications.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Future NASA Earth Science missions require submillimeter-wave remote sensing instruments to monitor air quality, climate variability and change, ozone layer stability, weather, and the global hydrological cycle. A key enabler for this technology is the F-band (106-114 GHz) solid-state power amplifier (SSPA) described in this proposal. This amplifier is need for the LO multiplier chain of the Scanning Microwave Limb Sounder and for the SOFIA (Stratospheric Observatory for Infrared Astronomy) airborne observatory. and other NASA missions. Currently available W/F-band SSPAs



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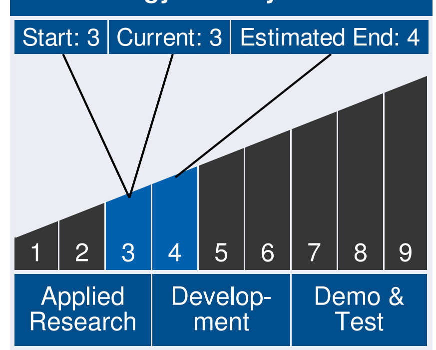
Technology Maturity



simply do not have enough power at this frequency, and further, their efficiency is poor. The efficiency SOA for amplifiers in the adjacent W-band is in the range of 15%, and with practical packaged amplifiers including regulators, the efficiency is often in the single digits. Our approach addresses this need by utilizing high-efficiency wide-bandgap (GaN) device technology and new high-efficiency power combining techniques to reach efficiency levels of 30%. Other NASA applications include LO multiplier chains for THz sensors studying star formation and neutral oxygen (ROSES 2013 APRA proposal). Further, W/F-band FMCW sensors are required for planetary exploration missions to assist in planetary landings. NASA applications require output power levels ranging from less than a watt to perhaps tens of watts at these W/F-band frequencies.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Applications for this high-efficiency amplifier technology abound at DoD, but at slightly lower frequencies, primarily the atmospheric window at 94 GHz. These include airborne applications such as helicopter landing and obstacle detection/avoidance radars, very high altitude long duration reconnaissance UAV applications, W-band missile seekers (e.g. AARGM missile) and DoD's W/V-band communications (e.g. Air Forces' WSCE and DARPA's Mobile Hotspots programs). Space-based applications include broadband RF cross-links in satellite constellations, and W-band downlinks for Mobile Hotspots. Specific examples include the Joint Arial Layered Network (JALN), the ICD effort from STRATCOM and AISR. Further, this GaN MMIC technology can be readily applied to other military missions at adjacent frequencies, E and V band. In all these airborne and satellite applications, efficiency is particularly important due to limited availability of prime power. Further, using power combining techniques, this high-efficiency MMIC technology can be extended to applications requiring higher power levels. With the proposed 1-watt MMIC chip as a building block, we can readily

Management Team

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- Joseph Grant
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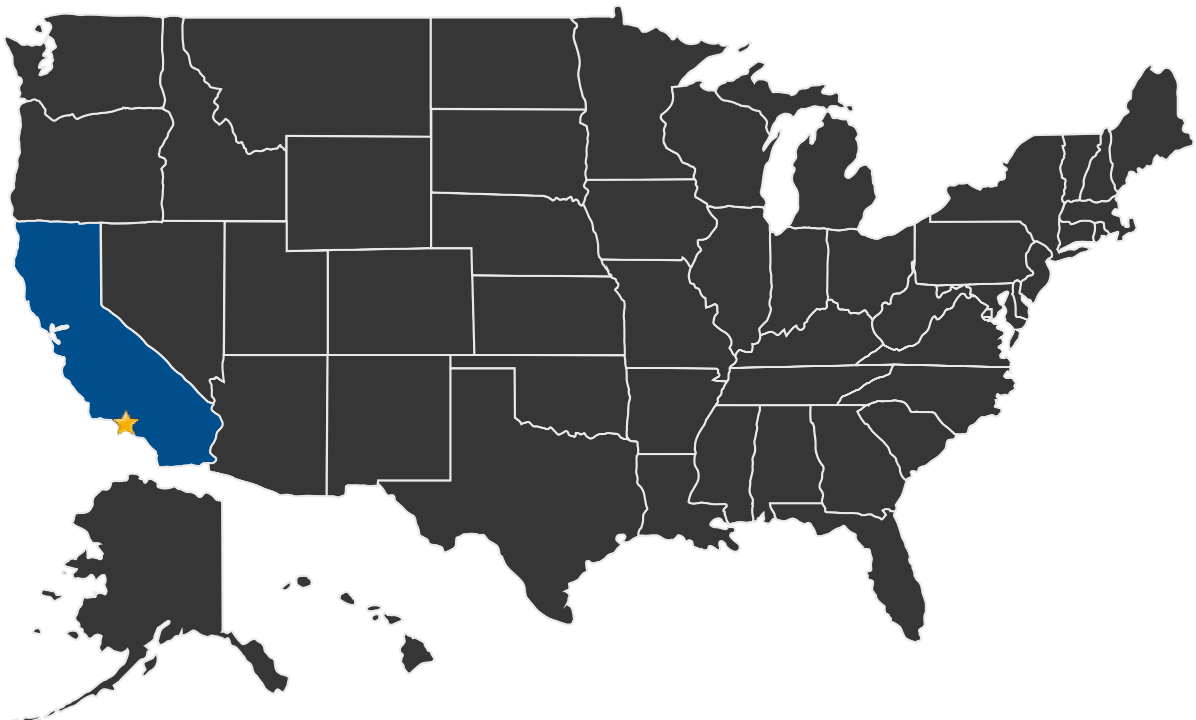
Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Radio Frequency Communications (TA 5.2)
  └ Power-Efficient Technologies (TA 5.2.2)
    └ Solid-State Power Amplifiers (SSPAs) (TA 5.2.2.2)

Secondary Technology Area:
Science Instruments, Observatories, and Sensor Systems (TA 8)
└ Remote Sensing Instruments and Sensors (TA 8.1)
  └ Microwave, Millimeter-, and Submillimeter-Waves (TA 8.1.4)

extend this technology to applications requiring tens of watts.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

- Quinstar Technology,Inc (Torrance, CA)

DETAILS FOR TECHNOLOGY 1

Technology Title

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